



The Human Health Criteria Formula

Presentation #2: Risk, Exposure, and Uncertainty in HHC Formula

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Conservation
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How are HHC derived?

- The HHC formula determines the degree of risk to humans from exposure to certain pollutants
 - Risk = Toxicity * Exposure * Uncertainty
- Science provides us with basic information
- Policy tells us how to apply that information
- Risk Management is a matter of publicly weighing options and making a decision



4 Equations to Calculate Human Health Criteria

Input Variables (2015 recommended)

BW = Human Body Weight (adult = 80 kg = 176 lbs)

DI = Drinking Water Rate (2.4 liters/day)

CSF = Cancer Slope Factor (mg/Kg-day) AKA (RSD)

FCR = Fish Intake Rate (? grams/day)

BCF/BAF = Bioconcentration v. bioaccumulation factor (L/Kg, chemical specific)

RfD = Reference Dose, Non-Carcinogens (mg/Kg-day)

RL = Risk Level (10^{-5}) in Alaska

RSC = Relative Source Contribution

	Freshwater Criteria (Consumption of Organisms and Water)	Marine Criteria (Consumption of Organisms Only)
Criteria for Carcinogens	$\frac{RL \times BW}{CSF \times [(FCR \times BCF) + DI]}$	$\frac{RL \times BW}{CSF \times FCR \times BCF}$
Criteria for Non- Carcinogens	$\frac{RfD \times RSC \times BW}{(FCR \times BCF) + DI}$	$\frac{RfD \times RSC \times BW}{FCR \times BCF}$

Slide Images and Inspiration courtesy of Washington Ecology



HHC Formula- Carcinogens

Freshwater Criteria
(Consumption of Organisms
and Water)

Marine Criteria
(Consumption of
Organisms **Only**)

RL: Risk Level (10^{-5})

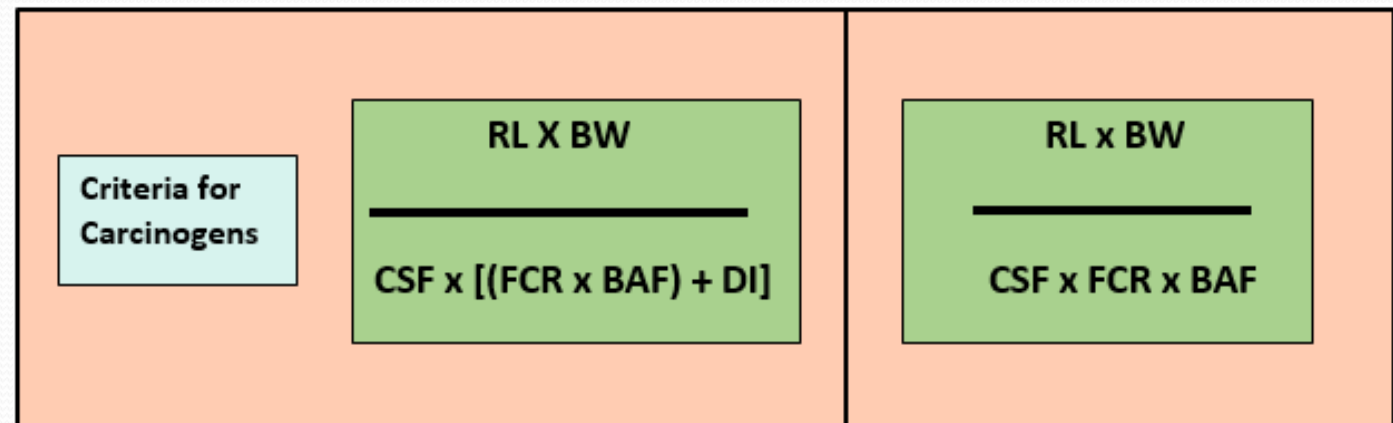
BW: Body Weight

CSF: Cancer Slope Factor

FCR: Fish Consumption Rate

BAF: Bioaccumulation

DI: Drinking Water Intake





HHC Formula- Non Carcinogens

Freshwater Criteria
(Consumption of Organisms
and Water)

Marine Criteria
(Consumption of
Organisms **Only**)

RfD: Reference Dose (mg/Kg-day)

RSC: Relative Source Contribution

BW: Body Weight

FCR: Fish Consumption Rate

BAF: Bioaccumulation

DI: Drinking Water Intake

Criteria for Non -
Carcinogens

RfD X RSC X BW

—————
(FCR X BAF) + DI

RfD X RSC X BW

—————
FCR X BAF



$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Toxicity: Reference Dose (Non-carc)

- RfD/CSF is a toxicity value derived by EPA and published in the IRIS catalogue.
- **Uncertainty is accounted for in the RfD/CSF.**
- Typically has a safety factor of 10-1000 is built into the value to account for intra-species and differences between animals and humans.

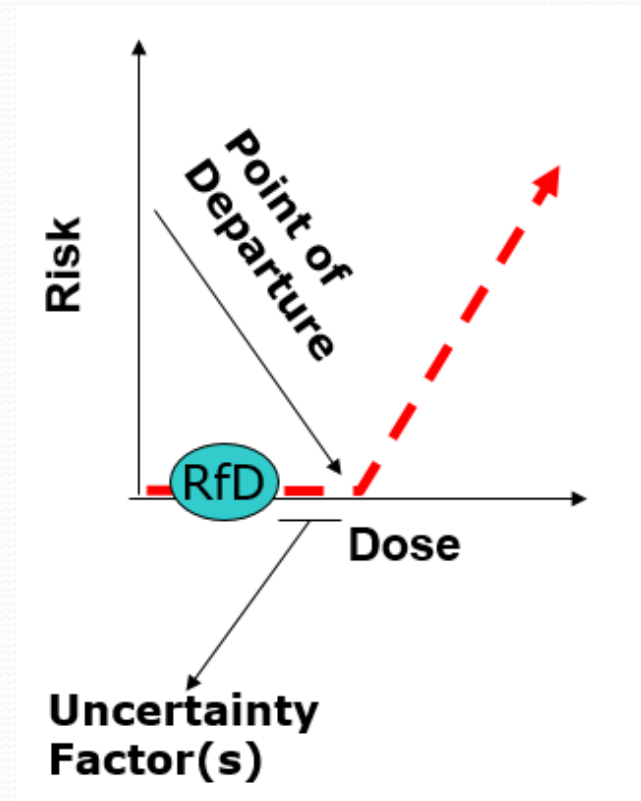
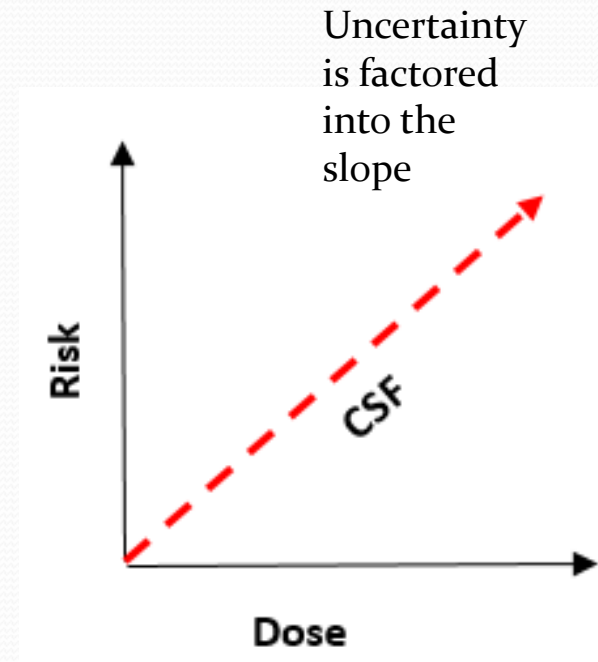


Image: Oregon DEQ

$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Toxicity: Cancer Slope Factor

- CSF is a toxicity value derived by EPA and published in the IRIS catalogue.
 - Doesn't consider a toxicity threshold or point of departure
 - CSF accounts for uncertainty
 - Typically has a safety factor of 10-1000 is built into the value to account for intra-species and differences between animals and humans.





$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Exposure

- Exposure = contact between an agent and the visible exterior of a person

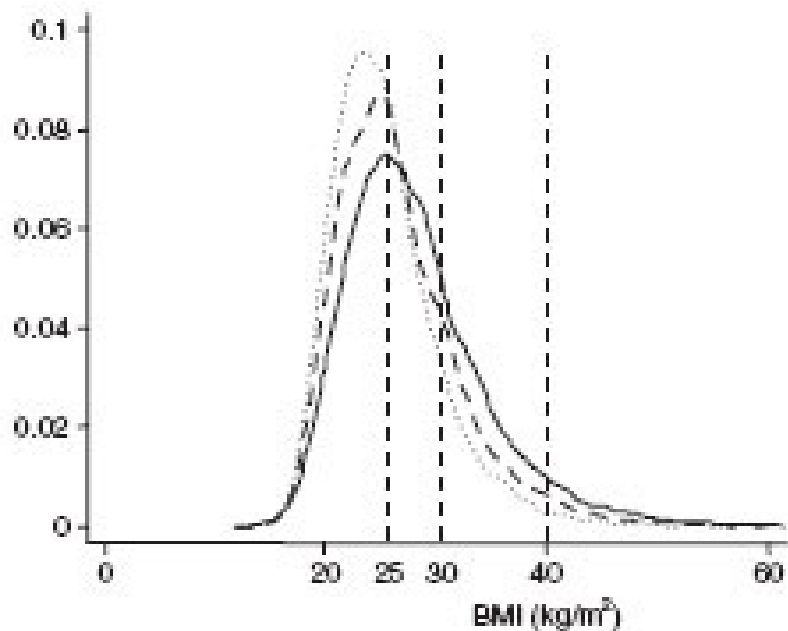
(Exposure (magnitude, frequency, duration) / Time)

- HHC Exposure Factors
 - BI= Body weight (fixed at 70 kg (80kg)) (176 lbs)
 - DI= Drinking water intake (fixed 2 liters (2.4 L))(2.5 quarts)
 - FCR = Fish Consumption (varies per state)
 - BAF= Bioaccumulation Factor (varies by trophic level but fixed at specific values)



$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Exposure: Body Weight



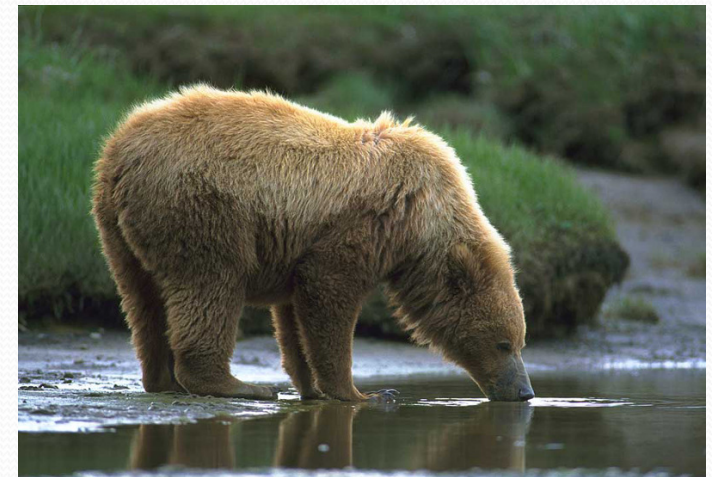
- Bodyweight is based on a fixed EPA-recommended value
- Updated 2015 = 80 kg (176 lbs)
- Update based on NHANES (1999-2006) data



$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Exposure: Drinking Water Intake

- Drinking Water is based on fixed EPA-recommended value.
- 2000: 2 liters per day. Inc. all sources of water (e.g., drinking water, coffee, other beverages/food derived water)
- 2015: Settled on 2.4 liters per day. Consistent with 2011 EPA Exposure Handbook values





Risk = Toxicity * Exposure * Uncertainty

Exposure: Fish Consumption Rate/Range (FCR)

- Per EPA: States/Tribes should consider developing criteria that uses the best local data available that is representative of their target population group(s)
- Geographic/demographic differences are anticipated therefore EPA developed a preference hierarchy:
 - EPA default intake rates (22 g/d for general /142.4 g/d for subsistence)
 - Data from national surveys (NHANES or other)
 - Data reflecting similar geography/population groups (Region 10 states (175))
 - **Local Data** (Alaska-specific)



Risk = Toxicity * Exposure * Uncertainty

FCR Preference Hierarchy, Cont.

- **Use of Local or Regional Data**
 - Use local data for freshwater/estuarine species
 - Use of uncooked weight intake values
 - Use high-end values (90th or 95th percentile) **or** average values for high consuming fish population (if using mean, should base on consumers only).
- Fairly common practice for states to develop HHC values based on local data (ME, NY, MN, WI, OR, WA (Regional approach), ID (in progress))



$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

HHC: Population of interest: General or subset?

💧 The fish consumption rate (FCR) in the HHC should reflect the rate of consumption by the **population of concern**

💧 (Mean, 90th, 95th, 99th)

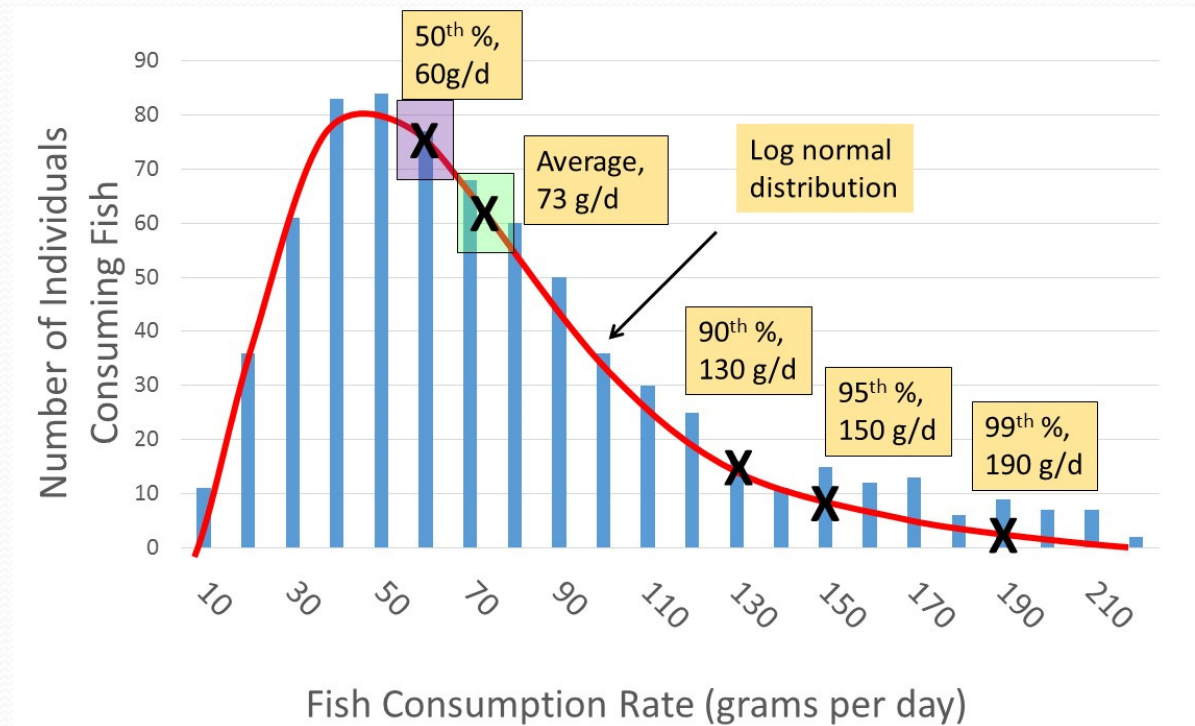
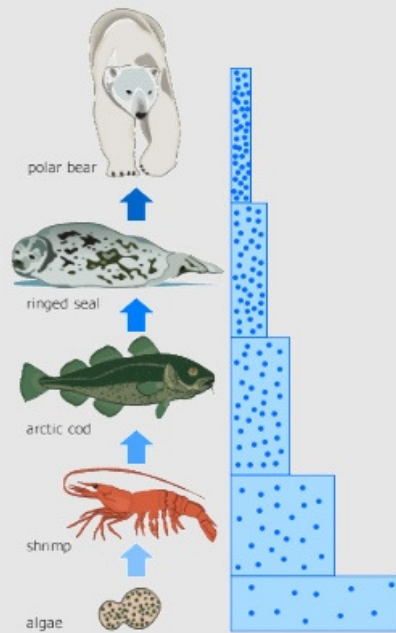


Image provided by EPA-R10

$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$

Exposure: Bioaccumulation Factor (BAF)

biomagnification and
bioaccumulation



- 💧 BAF = exposure to a pollutant through diet, water contact, and trophic position (where in the food chain)
- 💧 BAF can range from 1- 1000's for highly bioaccumulative compounds (e.g., PCBs)
- 💧
 - 💧 Low bioaccumulation = ↑ exposure from drinking water
 - 💧 High bioaccumulation = ↑ exposure from eating fish

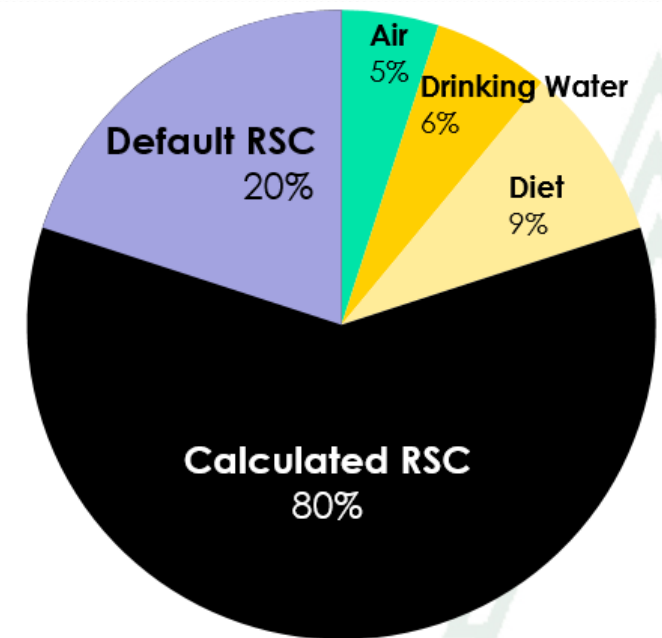
EPA currently recommends adoption of a BAF based on trophic level (2-4)

$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$



Uncertainty: Relative Source Contribution (non-carcinogens)

- Meant to account for non-water sources of exposure to **non**-carcinogens
- Estimates total amount of exposure from water and FC and potential exposure to other sources (e.g., air, food)



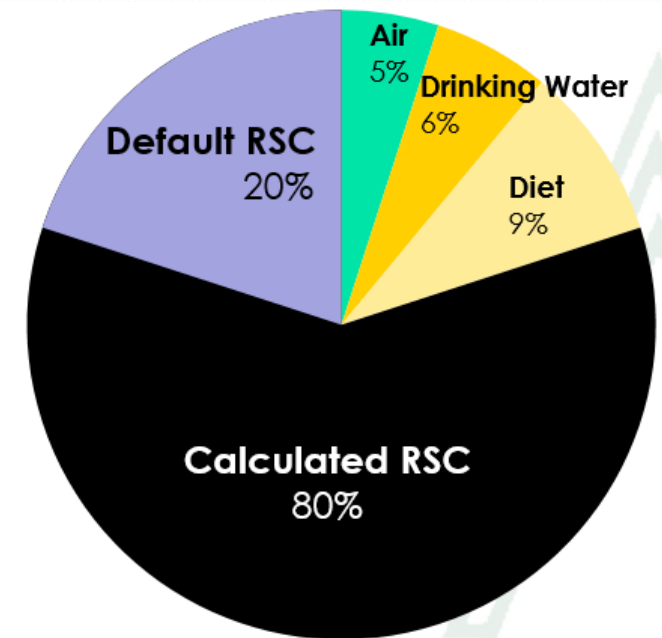
The pie chart represents 100% of the allowable daily dose (i.e., Reference Dose)

$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$



Uncertainty: Relative Source Contribution (non-carcinogens)

- 2015: EPA Default value of 0.20 in most cases- the lower the value, the more is attributed to other sources. Can be adjusted up to 0.80 max.
- Lowering of HHC provides additional room for other sources-but not their regulation.



The pie chart represents 100% of the allowable daily dose (i.e., Reference Dose)

$$\text{Risk} = \text{Toxicity} * \text{Exposure} * \text{Uncertainty}$$



Uncertainty: Suppression?

- Suppressed FCR can be attributed to contamination (i.e., polluted water/fish) and/or depletion (lower population)
- EPA *HHC Frequently Asked Questions* (2013): “It is also important to avoid any suppression effect that may occur when a fish consumption rate for a given subpopulation reflects an artificially diminished level of consumption from an appropriate baseline level of consumption for that subpopulation because of a perception that fish are contaminated with pollutants.”
- Additional guidance appears to be forthcoming...



Recap: HHC is a **formula** with numerous factors to consider

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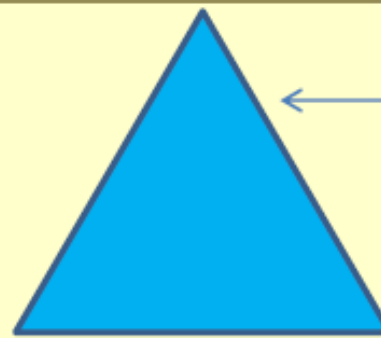
"Less -protective" decision-bucket

Criteria inputs and
risk management
decisions that
result in **lesser**
levels of
protection

"More protective" decision-bucket

Criteria inputs and
risk management
decisions that
result in **greater**
levels of
protection

"Reasonable"
level of
protection



← This teeter-totter represents
the balancing point between
"over-protection" and
"under-protection."

← ——— "Under-protection"

"Over-protection" →



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Questions?
Thank you for your time!

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